Municipal Solid Waste Management in Coastal line of Gilan Province

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Abstract

Sea shores of Gilan Province is one off the biggest tourist attractions in Iran. This area have valuable forests and grasslands. In addition it provides significant amount of corps like rice, tea, olive. Considering this facts, environmental protection of this area must be priority for national government. However waste management instruction have been ratified in Iran, there isn't any specific rules for coastal areas. To obtain rules and instruction in coastal areas it's necessary to study its current condition. This article describe this situation buy field study of this area. Next to that rules and directive of coastal areas in developed countries studied and main features of this instruction defined. At the last stage current situation of Gilan's coastal line was studied and finally rules and instruction drafted. Results shows 466 tons of waste is generated in 12 cities of this Province, or 1.7kg of waste per capita in each day. Main consistence of waste are food waste, paper and plastic which include 66, 12 and 14 percent of waste respectively. This lead to chemical formula of $C_{706}H_{1120}O_{360}N_{16}S_1$ and C/N ratio of 44.homeless people and municipality workers separated large amount of waste to sell plastics, papers and glasses, but there is no managed separation. There are only two compost facilities and the rest of waste disposed in open dumps which cause several difficulties and environmental pollution.

Keyword: Waste Management, Coastal line, Caspian Sea, Directive

1. Introduction

Substances from municipal waste not only cause soil pollution of disposal site but also may contaminate nearby Surface and Groundwater Resources. In addition they can puts human and wildlife health at risk. Solid wastes is a major source of coastal ecosystems pollution, which entered to these ecosystems from various ways, for example it's one of most visited area for tourists and the waste from there activity is one of these ways.

Around 80 percent of sea pollution around the world is from land source, the other 20 percent is from sea source (e.g. waste from boats, Freighters, Oil platforms, etc.). This is a widespread problem which affect large area like harbors, Rivers mouth and coastal towns. Waste in coastal area deforms beautiful seaside landscape moreover the degradation rate of wastes such as plastic is slow because of high levels of ground water and humidity, and it may take over 300 years. (Mojtaba, et al., 2013)

Waste management is a set of action to organize wastes with engineering methods. It Include wide range of materials and various sources. (Abdoli, et al., 2011) (Abdoli, 1993)

Waste management in coastal area is the first and most important step to maintain these areas sanitary, Cleaning up and keep the ecosystem alive.

The management of solid waste continues to be a major challenge in urban areas throughout the world, but particularly in the rapidly growing cities and towns of the developing World. Urban areas in Asia produced approximately 0.76 million tons of municipal solid waste (MSW) per day in 1998, which is expected to rise to 1.8 million tons by 2025. China alone produced 0.14 billion tons of MSW in 1998. Keeping pace with the requirements of rapid economic development and continuing population growth, and because of its critical role in protecting the environment and public health, accomplishing effective and efficient municipal solid waste management should be a priority for cities of the developing countries. (Jin J, 2006)

The most important (and also longest) coastal area in Iran are Persian Gulf and Gulf of Oman in south with about 2530km long and Caspian Sea in north with about 922km long. Coastal pollution in developing country cause various difficulties for these sensitive ecosystem. For example In Mahashtera Seashore especially in its Mangrove forests different kind of municipal and industrial waste scattered and large area is covered by plastic bags. (Abdoli, 2002)

During past decade quantity and compounds of municipal solid waste in cities of southern Caspian Sea coastal area have been changed considerably but collection, transporting and dumping methods are still the same as before. (Abdoli, 2006)

In current years Istanbul make a great progress in using waste management system with sanitary landfills and methane recovery system which predicted to produce about 160MW electricity energy during 10 years. (Berkun M, 2005)

Another sample for waste management system is Macau in China this city lies on the western side of the Pearl River Delta. Before 1990 waste used to bury in landfills. But this solution can't be used anymore because of lake of lands and its high value. So it was decided to Change the priority from landfilling to incineration of waste. Landfilling is the last option and only wastes with low heat value or not suitable for incineration is buried now. (Jin J, 2006)

SCRD[1] (in southern part of British Colombia, Canada) use a different solution for waste. In this district Municipal solid waste buried in landfills, but construction and demolition waste carried out of region by private companies. In addition there are Second-hand shops and online stores with delivery system which encourage reusing. (AECOM, August 2011)

The lack of efficient waste management system can bring irreversible damage to the health of society and the environment. (Abdoli, et al., 2013) The most essential part of a Waste management system is its rules and directives. Absence of regulations can lead to inefficient waste management system.

In this article, the current condition of waste management in Gilan province (Iran, South of Caspian Sea) were studied and Strengths and weaknesses of the existing system was evaluated and at last the rules and guidelines for waste management in this coastal zone is suggested.

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[1] Sunshine Coast Regional District

2. Materials and Methods

2.1 The study area

The study area lies between 36°33'N and 38°27'N Latitude, and 48°32'E and 50°36'E Longitude. Gilan Province with about 13953 km^2 dominate 0.8 percent of Iran total area. Its maximum altitude is 3050m and in coast line of Caspian Sea it is 28m below Mean sea level. According to statistical center of Iran (2011) there are 51 cities in this province which 13 of them located in coast line (Akbari & Sanayii, 2010) (Figure 1).
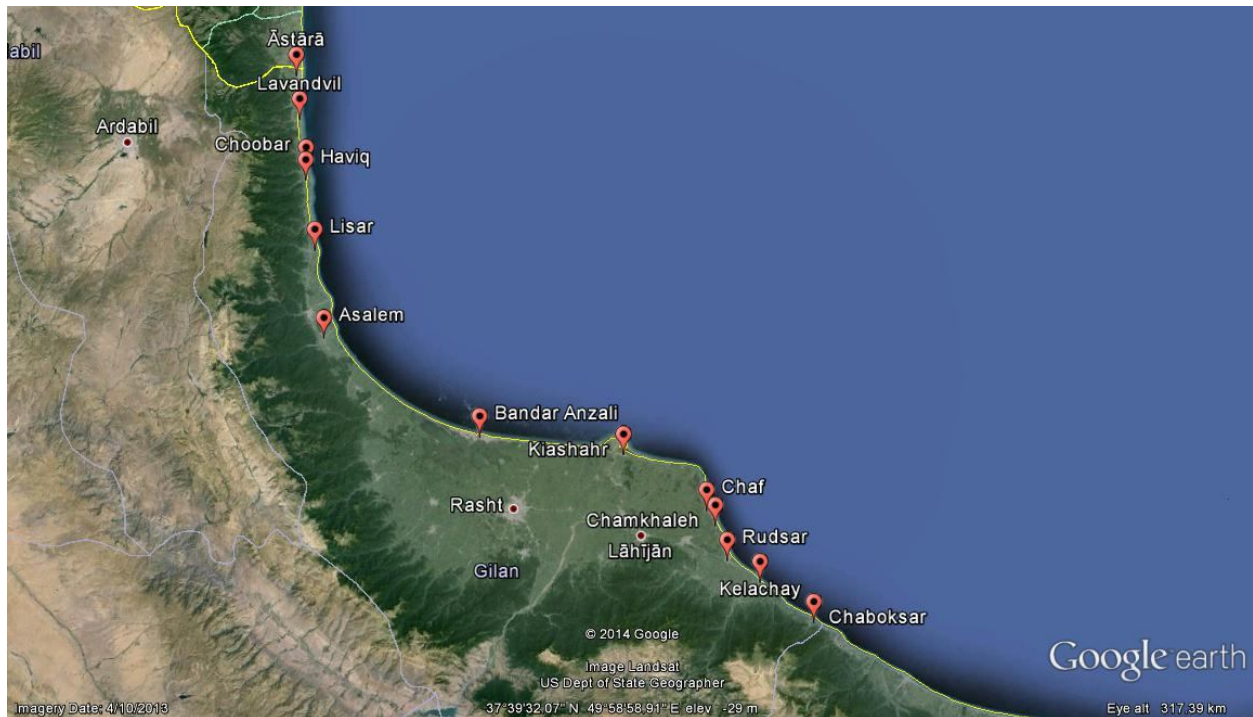

Figure 1 - Gilan Province and its Coastal Cities (satellite image by google earth)

2.2 Research Methods

Preparation of rules and directives needs knowledge about current condition of waste management in Gilans coastal area. Studying quantity and quality of waste generation can provide a clear view of current waste management situation and the strengths and weaknesses of existing systems can be evaluated. In this paper, after literature review, the newest information and statics form authority like recycling organization of Gilan or municipalities of coast line cities and Gilan provincial directorate of environmental protection gathered and studied.

For more accuracy, Fields were visited, several expertise were interviewed and also a survey was conducted. The main structure of proposed directive was obtained by reviewing guidelines an instruction of waste management system in developed countries. At last comparative studies were done considering current condition of area, and proposed directive was obtained.

3. Conclusion and Results

3.1 Waste Generation

Total weight and waste generation per capita are given in Table 1 . Total waste generation in these cities is 466 ton/day, Maximum and minimum waste generation belong to Bandar Anzali and Choobar respectively. These cities generate 1.7 kg of waste.day^{-1}.capita^{-1} which is much higher than national average of 0.75 kg of waste.day-1.capita-1. This could be due to their tourist attractions. Maximum and minimum waste generation per capita belong to Rudsar and Choobar respectively.

None of these cities have any rules or directive for shape, size, type or material of containers to collect the waste in generation area, many houses use plastic bucket or old metal barrel with plastic bag in it to keep the waste in place and the waste placed beside sidewalk in these plastic bags for collection.

Table 1 The amount of waste produced by coastal cities of Gilan province (2013) (Mojtaba, et al., 2013)

City	Population	The amount of waste generated per day (tons)	Waste generated per capita per day (kg)
Chaboksar	6994	10	1.43
Kelachay	11936	22	1.84
Rudsar	37579	90	2.39
Chaf and Chamkhaleh	4494	8	1.78
Kiashar	13753	25	1.82
Bandar Anzali	116664	160	1.37
Asalem	10040	10	0.996
Lisar	3262	6	1.84
Choobar	5522	5	0.91
Haviq	4194	10	2.38
Lavandvil	10617	20	1.88
Astara	48470	100	2.06
total	273525	466	1.7

Figure 2 shows the components of the waste. Organic waste with 64 percent, paper with 12 percent and plastic with 14 percent of total weight dominate the largest part of waste. These

values put the recycling program in the priority and the chemical formula of the waste is $C_{706}H_{1120}O_{360}N_{16}S_1$ and the C/N ratio would be 44.

Organic waste fraction of 64 percent is a high value and it's because that the local people use fresh food instead of prepared food. Dry waste contain up to 36 percent of total waste, by source separation it can be reduced to 2 percent. Up to 97 percent of waste is incinerable, so using of incinerator can reduce 95 percent of wastes volume. But price, setup, operation and maintenance cost of these system must be considered.
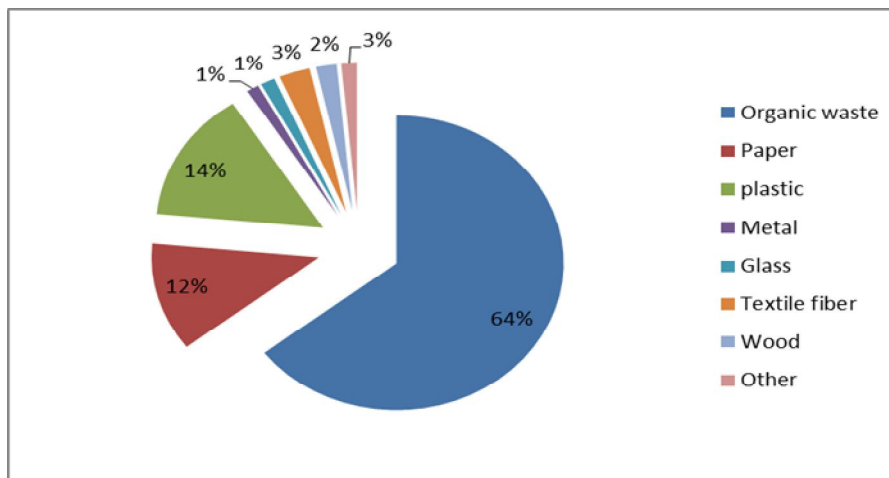

Figure 2 waste fractions of Gilan coastal cities 2013 (WMOG, 2013)

3.2 Collection

In the study area, waste collected each day and transported to the disposed site. The survey showed that in all the cities except Asalem waste collection conducted by the municipalities. Table 2Table 1 shows the collection vehicles. There are 99 carts, 45 pickups, 8 dump trucks, 24 waste management trucks and a Tractor.

Table 2 waste collection vehicles in different cities (2013) (Mojtaba, et al., 2013)

City	Number of machines				
	w.m. truck	dump truck	Tractor	Pickup	Cart
Astara	6	2	0	12	30
Asalem	1	0	0	1	0
Bandar Anzali	8	3	0	20	46
Kiashar	1	0	0	3	0
Chaboksar	1	1	0	0	5
Rudsar	3	1	1	4	12

3.3 Recycling

In all of these cities waste is recycled and separated by municipalities. In all cities waste separation by municipalities' workers have been seen during collection. But it doesn't mean that all the workers do the waste separation. In addition some homeless persons separate the waste in cities or at disposal sites to find cardboard, paper, glasses or plastics. There are also two compost facility in Rudsar and Bandar Anzali but they have some functional problem and they don't work at its maximum production capacity. Survey shows that 18 percent of waste separation (by municipalities' workers or homeless persons) is done in transfer stations, and 82 percent at disposal site, All of them separate plastics an metals, 75 percent separate paper and cardboard and 40 percent separate glasses. So a large part of the waste is recycled and sold by them.

3.4 Disposal

Table 3 shows waste disposal method in different cities. In most cases there is no sanitary landfill (waste disposed in open dump) and none of them have any leachate treatment system. There is only two compost facility in Rudsar and Bandar Anzali which can't work effectively and they are being optimized however after building of Bandar Anzali's compost facility the old waste disposal site closed and it's planned to convert it to a green space. In addition domestic wastes of Chaf and Chamkhaleh after collection, is transported to Rudsar disposal site.

Except for Lisar and Choobar the rest of cities dump waste in coastal line and leachate seep to the sea throw the site's soil.in addition in these area the ground water level is almost high (4.3 m in average) and leachate can leak to the ground water resource.

Hashtpar and Vajargah are not coastal cities but they dump waste in coastal line.

Table 3 waste Dispose situation in coastal cities of Gilan (Mojtaba, et al., 2013)

City Name	Disposal Site	Disposal Method	Location Toward Water Resource	Nearest Water Resource and Distance	Ground Water Level	Leachate Treatment
Asalem	Alalan District – In Caspian Sea Shore	Open Dumping	Sea Shore	Caspian Sea -500m	4m	Unmanaged
Astara	Dadashabad District - Next to Lavandvil Protected Area	Open Dumping	Sea Shore	Caspian Sea -300m	5m	Unmanaged
Kiashar	Marzbani District – Next to Bojagh National Park	Open Dumping	Sea Shore	Caspian Sea -1000m	1m	Unmanaged
Chaboksar	Beside Khazarnoosh Factory	Open Dumping	Sea Shore	Caspian Sea -1000m	4m	Unmanaged

City Name	Disposal Site	Disposal Method	Location Toward Water Resource	Nearest Water Resource and Distance	Ground Water Level	Leachate Treatment
Rudsar	Near Zaqutsar Pond	Open Dumping	Sea Shore	Caspian Sea -600m	3m	Unmanaged
Kelachay	Behind city's fire station – Sea Shore	Open Dumping	Sea Shore	Caspian Sea -400m	4m	Unmanaged
Lisar	Lisar's River bank	Open Dumping	River	-	5m	Unmanaged
Haviq	Southeastern of Talesh -In Caspian Sea Shore	Open Dumping and Burning	Sea Shore	Caspian Sea -1500m	2	Unmanaged
Choobar	East of Talesh - near pine forest	Open Dumping and Burning	River	-	10	Unmanaged
Vajargah	Near Lazarjan	Open Dumping	Sea Shore	Caspian Sea -800m	5m	Unmanaged
Hashtpar	Ghorog District's Shore	Open Dumping	Sea Shore	Caspian Sea -700m	4m	Unmanaged

3.4.1 Main Environmental Problem of Disposal Sites

1- Waste is not landfilled sanitary and being dumped over the site.

2- Dumping sites are not surrounded and wastes spread over the nearby lands.

3- Livestock enter dumping sites and eat wastes which spread pathogens and cause zoonosis disease

4- There is no leachate collection and treatment. Leachate polluted surface and ground water resource it also seeping to the nearby farms and contaminate them.

5- Fire caused by methane releases from waste degradation (there is no gas collection system in these dumping sites) or persons how separate the waste. Fire Also cause bad odor and air pollution.

6- Inefficient and incomplete chain of waste management system

7-Municipalitis ignoring sanitary methods and environmental standards in managing disposal sites

8-air pollution and bad odor cause difficulties for nearby recreational facilities and tourist places and put the public health in danger especially during hot seasons.

9- There is no guard in many sites to prevent non- authorized persons from entering disposal sites

10- Lack of proper organizational structure, Skill shortage, insufficient financial resources, absence of ancillary industries and lack of up to date technologies.

3.5 Rules and instructions

The main purpose of creating standards is to achieve unification in rules and directives so waste management programs have necessary quality. In other word standards provide a reference for monitoring deferent part of waste management system and they are not rigid in fact generalizability and applicability in different situations with minimum modification are the main features of an appropriate standard. But during application of standards it's always possible that it facing with unanticipated situation in which, following all the standards would be impossible. In such a case it must be tried to stay close as much as possible to the standards boundaries. In other hand in some areas rules and instruction can't handle needs of waste management systems. So Technical and economic feasibility reports during construction of waste management facility Can improve our knowledge about issues of each area and prevent further problems.

3.5.1 Waste management rules and directives features in coastal line of developed countries

Today's solid waste management system in developed countries have been formed and developed since late 30s decay. Before that main purpose of waste management systems was to remove waste from residential area. The number of functional elements in waste management system changed from 3 in 1930 to 8 in these days and it shows the improvement in services and waste management standards in developed countries. Coastal areas as tourist attraction has important rule in public health and environmental protection, lack of appropriate rules in these areas can be a threat for nearby cities and environment. (Abdoli, 2006)

Rules and instructions in developed countries provide necessary standards for design, manufacture, installation, operation and maintenance of waste transport, recycling and disposing equipment to achieve following goals:

- Developing program to manage recyclable wastes
- Improving society's safety, health and welfare
- Preventing surface and ground water pollution
- Preventing air pollution
- Preventing spread of pathogens
- Protecting Natural resources
- Protecting and Improving Environmental standards

These rules include following branches (Hawaii Administrative, 2005)

a) Usage
b) Application for work License
   - Analysis of facility location
   - Evaluation of Design Criteria
   - Facility operation plan
   - Facility closure plan
c) Reporting

Rules and instruction of solid waste management are updated and published regularly but the main problem is in application of these rules. Solid waste management rules covers a wide range of concerns in waste managing. These rules contains necessary criteria for collecting, transporting and dispose as well as burying or incinerating of wastes. These rules also consider design and operation of landfills and incinerators. In addition they have a special focus on minimizing plastic wastes and encourage recycling. (Berkun M, 2005)

Procedures provided in the rules are hierarchically structured. At first by understanding the primary purpose of project, needs and usage of each facility classified. Then required documents is submitted to apply for Initial license. Required documents show different detail for each fields of utilities. By analyzing these details such as utilities placements and layouts, buildings' location and there field of work and list of equipment for now and in the future, provide better control for authorities over the facility.

3.5.2 Waste management rules and directives features in coastal line of Gilan Province

Any rules or directive must be based on culture, customs, commercial and economic activity of that society, so it can reach to its final goal which is implantation.

Without considering this fact and simply using laws of other countries, will cause various problems or difficulties for the authorities. In addition incomplete rules makes it easy for abuses. Because of this, any rules or instruction must have following features:

1- Simple, expressive and without any ambiguity
2- Applicable in current condition
3- All parameters investigated and be affected.
4- Individual tasks is specified.
5- Ability to be updated with regard to problems in the future.
6- In line with the present laws of the country.
7- In line with cultural, political and economic facts of society.
8- penalties for violations must be clear and decisive

In order to achieve mentioned features following items must be considered:

1- Population growth.
2- Demographic changes (including migration out of the countryside into cities and changing habits and behavior of people in towns and villages)
3- Industrialization and economic growth
4- Changes in food habits and consumption of society
5- The creation and institutionalization of rules to reduce the consumption patterns

With to basic assumption in creating rules or instruction, Sources of pollution can be reduced.

First, all the process must have a comprehensive and coordinated approach that include all parts. It also should consider interacts between soil, water and air. Any effort to protect an environmental section without studying its impact to other parts would be a failure and it would be wrong both scientifically and morally.

Second, although more scientific information is needed, the current lack of information shouldn't be a setback in start of waste management.

In general, the overall structure of the proposed regulations are as follows

1- Goal
   a) Maintaining human health and the environment against the dangers of improper waste management methods in different stages of separation, processing and recycling in coastal line.
   b) Implementation of source separation procedures to separating valuable recyclables from main stream of wastes in coastal areas.
   c) Natural resource and beauty of nature conservation
   d) Prevent the spread of pollution and pathogens from waste
   e)
2- Definitions
   Concepts and terms used in the instructions is provided in this section.

3- Executive Management of Waste
   Any natural or Legal personality how is responsible for planning, organizing, monitoring and operation related to Production, collection, storage, separation, transportation, recycling, processing and disposal of waste. According to article 7 of Iran waste management Law, Executive Management of all waste kind – except for industrial and special wastes – is a responsibility of local government. Executive management of industrial and special waste is a responsibility of producer.

4- Executive Items
   Functional element's responsibility described here which include source reduction, collection, processing, transporting and dispose, and also statistics for waste management systems have been proposed. And finally according to different requirements, study of existing situation, special conditions of Caspian Sea coastline in Gilan province and experiences of developed countries following executive Items were suggested:

   a) Management approach
      Management framework should include appropriate planning, evaluation, financial institutions and legislation in all scale of local, regional or national. Actions to reduce or prevent emissions are important parts of this approach. In addition there are policies to control human settlements and economic development of coastal areas, wetlands and adjacent seas.

   b) Pollution control
      Pollution control needs a cradle to grave approach in use of resources and chemical materials. Which include recycling, clean production, high-grade control processes, more efficient production and distribution systems and precise management of hazardous side products.

   c) Banning hazardous wastes
      Some hazardous wastes or substance persist for long time should be banned or restricted.

   d) Constant management rules

Rules must be constantly applied to reduce, separate, recycle, and choose the safest way to dispose waste.

e) Precautionary approach
Precautionary approach is necessary to reduce waste and controlling pollution, by these rules damage and losses are anticipated and prevented.

f) Determining the goals
One of the basic procedure to create waste management system is determining the goals and environmental quality standards.

g) Information and education workshops
Workshops help to improve the public awareness about their rules in solving problems.
h) Monitoring and Evaluation Criteria
Define criteria for continuous monitoring and evaluation of projects.

i) Cooperation
Cooperation between developed and developing countries. Either bilateral or multilateral, which covers a range of similar areas.

j) Stable institutions
An effective and long lasting programs depends on stable and well-equipped institutions which concentrated on education. This institutions are better to developed locally.

These rules would create a hierarchy which include range of actions, from public awareness and scientific researches to potential problems and environmental decisions in all aspect of society and also implementation of efficient rules to prevent issues.

Satisfactory performance of these rules depend on: Identify sources of pollution, applying the appropriate regulatory standards and procedures, organizational arrangements to ensure the implementation of regulations and finally identify and solve problems that prevent or make delay for effective solutions.

4. Conclusion

The results shows that improper waste management in coastal area, cause several environmental problem. Increase in number of open dumping sites and its distribution and also poor performance of functional elements (like source reduction, processing and recycling) enhanced environmental degradation in the region. Open dumping is the only method that cities in this area use to dispose there wastes. According to studies none of these dumping sites use an appropriate leachate treatment or controlling system which cause surface and ground water pollution. However there are compost facilities in Rudsar and Bandar Anzali, they have low performance and their management faced with many problems. In order to achieve the maximum capacity and better performance in these facilities, waste separation must be done at its source which need education and public awareness. There are some workshops and educational advertisements but

these are still not enough. Waste management should be seen as a national problem and all the authorities must be involved in resolving it.

In developed countries rules and standards improved waste management system with current approach of waste to energy and waste reduction. In addition rules an instructions are a reference for monitoring the performance of various sectors in waste management

Waste management instruction in coastal line of Gilan province has been developed by considering current situation in this area and studying waste management of developed countries and their experience. Main propose of this instruction is to protect the environment and prevent deleterious effects of open dumping. Main features and framework of this instruction have been described. Following this instructions is suggested to all authorities of Gilan province.

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